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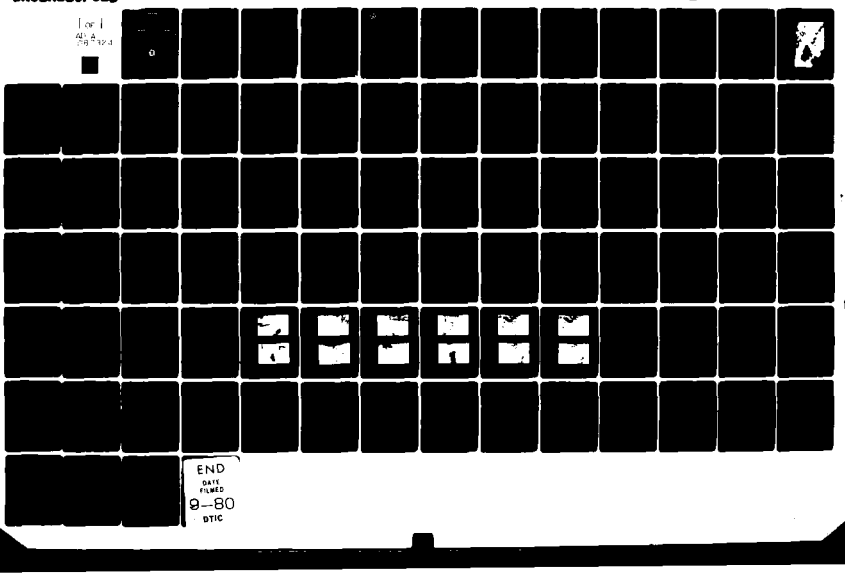

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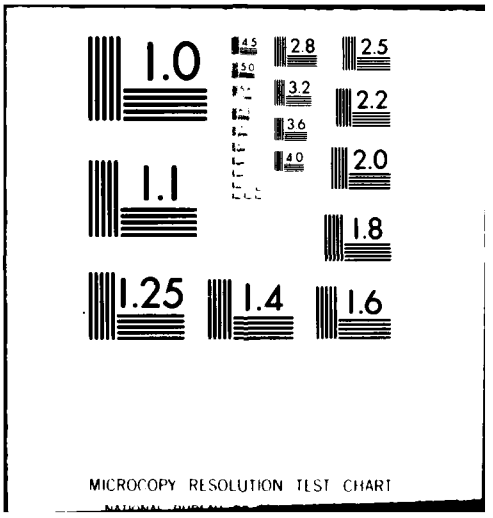
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DELAWARE RIVER BASIN
TRIBUTARY OF ALEXAUKEN CREEK
HUNTERDON COUNTY, NEW JERSEY

AMWELL NO. 2 DAM
NJ 00522

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

MARCH 1980

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National Dam Safety Program
Amwell No.2 Dam

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-N

24 JUL 1980

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Amwell No. 2 Dam in Hunterdon County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Amwell No. 2 Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in poor overall condition. The dam's spillway is considered inadequate because a flow equivalent to 19 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood.) To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Within three months of the consultant's findings, remedial measures to ensure spillway adequacy should be initiated.

b. The following actions should be initiated within six months from the date of approval of this report:

(1) The owner should develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

(2) The embankment should be thoroughly inspected by a professional consultant engaged by the owner. Based on the inspections, together with any necessary subsoil, seepage and structural investigations, remedial measures to correct the seepage and other possible causes of embankment instability, including the steep downstream slope and mounded soil at the toe, should be determined and implemented.

NAPEN-N
Honorable Brendan T. Byrne

(3) The owner should assure himself that the dam has an outlet works (low level drain) in functional condition and of adequate capacity.

(4) All adverse vegetation on the embankment should be removed and animal holes filled.

(5) Debris in the spillway discharge channel should be removed.

(6) The left training wall of the spillway discharge channel should be repaired or replaced.

(7) Because of the embankment condition a detailed topographic survey of the dam and area around the dam based on N.G.V.D. should be made. The survey map should become part of the permanent record.

c. Within one year from the date of approval of this report, the owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
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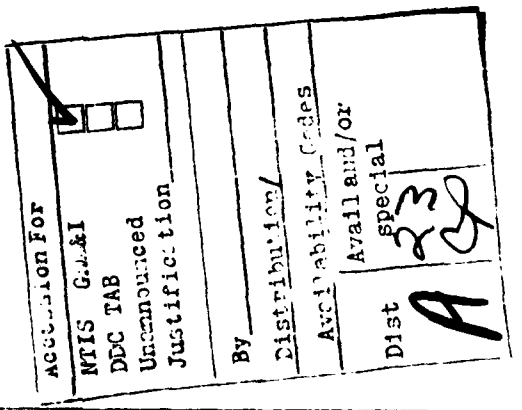

AMWELL NO. 2 DAM (NJ00522)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 19 November 1979 by Storch Engineers under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Amwell No. 2 Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in poor overall condition. The dam's spillway is considered inadequate because a flow equivalent to 19 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood.) To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Within three months of the consultant's findings, remedial measures to ensure spillway adequacy should be initiated.

b. The following actions should be initiated within six months from the date of approval of this report:

(1) The owner should develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

(2) The embankment should be thoroughly inspected by a professional consultant engaged by the owner. Based on the inspections, together with any necessary subsoil, seepage and structural investigations, remedial measures to correct the seepage and other possible causes of embankment instability, including the steep downstream slope and mounded soil at the toe, should be determined and implemented.

(3) The owner should assure himself that the dam has an outlet works (low level drain) in functional condition and of adequate capacity.

(4) All adverse vegetation on the embankment should be removed and animal holes filled.

(5) Debris in the spillway discharge channel should be removed.

(6) The left training wall of the spillway discharge channel should be repaired or replaced.

(7) Because of the embankment condition a detailed topographic survey of the dam and area around the dam based on N.G.V.D. should be made. The survey map should become part of the permanent record.

c. Within one year from the date of approval of this report, the owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 19 JUN 1980

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Amwell No. 2 Dam, NJ00522
State Located:	New Jersey
County Located:	Hunterdon
Drainage Basin:	Delaware River
Stream:	Trib. to Alexauken Creek
Date of Inspection:	November 19, 1979

Assessment of General Condition of Dam

Based on visual inspection, past operational performance and Phase 1 engineering analyses, Amwell No. 2 Dam is assessed as being in poor overall condition.

Based on investigations of the downstream flood plain made in connection with this report, it is recommended that the hazard potential classification be downgraded from high to significant.

Hydraulic and hydrologic analyses indicate that the spillway is inadequate. Discharge capacity of the spillway is not sufficient to pass the designated spillway design flood (SDF) without an overtopping of the dam. (The SDF for Amwell No. 2 Dam is equal to one-half the probable maximum flood.) The spillway is capable of passing approximately 9 percent of the probable maximum flood or 18 percent of the SDF. Therefore, the owner should in the near future engage a qualified professional engineer experienced in the design and construction of dams to perform more accurate hydraulic and hydrologic analysis. Based on the findings of the analyses, the need for, and type of remedial measures should be determined and then implemented.

The owner should, in the near future, develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

Extensive seepage and other indications of possible instability in the dam were observed. Therefore, the dam embankment should be thoroughly inspected soon by a professional engineer experienced in the design and construction of dams. Based on the inspection, together with any necessary subsoil, seepage and structural investigations, remedial measures to correct the seepage and other possible causes of embankment instability, including the steep downstream slope and mounded soil at the toe, should be determined and then implemented.

In addition, it is recommended that the following remedial measures be undertaken by the owner in the near future:

1) If it exists, the outlet works should be investigated and restored to a functional condition. If no outlet works exists, an adequate low level lake drain should be designed and installed.

2) All adverse vegetation on the embankment should be removed and animal holes filled.

3) Debris in the spillway discharge channel should be removed.

4) The left training wall of the spillway discharge channel should be repaired or replaced.

In the near future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to insure the safety of the dam.

A detailed topographic survey of the dam and area around the dam based on N.G.V.D. should be undertaken by a qualified licensed land surveyor or professional engineer in the near future. The survey map should become part of the permanent record mentioned above.

Richard J. McDermott, P.E.

John E. Gribbin, P.E.

OVERVIEW - AMWELL NO. 2 DAM

29 NOVEMBER 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that the unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

AMWELL NO. 2 DAM, I.D. NJ00522

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The Division of Water Resources of the New Jersey Department of Environmental Protection (NJDEP) in cooperation with the Philadelphia District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the State of New Jersey. Storch Engineers has been retained by the NJDEP to inspect and report on a selected group of these dams. The NJDEP is under agreement with the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspection of Amwell No. 2 Dam was made on November 19, 1979. The purpose of the inspection was to make a general assessment of the structural integrity and operational adequacy of the dam structure and its appurtenances.

1.2 Description of Project

a. Description of Dam and Appurtenances

Amwell No. 2 Dam consists of an earth embankment with a concrete wall running along the upstream face. A spillway consisting of a concrete, two-stage overflow weir is located at the west end of the embankment and oriented at 45° to the crest of the embankment. The dam which is oriented approximately east/west has an overall length of 285 feet. The top width of the embankment varies from 10 to 17 feet and the downstream face has a slope of 1.5 horizontal to 1 vertical. The spillway has an overall length of 20 feet and outlets into a chute-type discharge channel.

The elevation of the dam crest is 170.0, National Geodetic Vertical Datum (N.G.V.D.) while that of the toe is 150.8. The height of dam is 19.2 feet. The primary crest elevation of the spillway is 167.5 while the secondary crest elevation is 167.9.

b. Location

Amwell No. 2 Dam is located in the Township of West Amwell, Hunterdon County, New Jersey. Constructed across a tributary to Alexanken Creek, the dam impounds Amwell No. 2 Lake. Principal access to the dam is by an unimproved road north of the dam. The dam can be reached from Route 202 by travelling north on Mt. Airy Road to Station Road; then northeast on Station Road for approximately 0.7 miles where the unimproved road intersects on the right side.

c. Size and Hazard Classification

Size and Hazard Classification criteria presented in "Recommended Guidelines for Safety Inspection of Dams," published by the U.S. Army Corps of Engineers are as follows:

SIZE CLASSIFICATION

	Impoundment	
	Storage (Ac-ft)	Height (Ft.)
Small	< 1000 and ≥ 50	< 40 and ≥ 25
Intermediate	≥ 1000 and $< 50,000$	≥ 40 and < 100
Large	$\geq 50,000$	≥ 100

HAZARD POTENTIAL CLASSIFICATION

Category	Loss of Life (Extent of Development)	Economic Loss (Extent of Development)
Low	None expected (no permanent structures for human habitation	Minimal (Undeveloped to to occasional structures or agriculture)
Significant	Few (No urban developments and no more than a small number of inhabitable structures	Appreciable (Notable agriculture, industry or structures)
High	More than a small number	Excessive (Extensive community, industry or agriculture)

The following data relating to size and downstream hazard for Amwell No. 2 Dam have been obtained for this Phase 1 assessment:

Storage: 106 acre-feet

Height: 19.2 Feet

Potential Loss of Life:

Heavily used road is located approximately 2500 feet downstream from dam. Failure of dam could cause loss of life. Two dwellings are located 2000 feet downstream from the dam, adjacent to a downstream lake. The dwellings are approximately 8 feet above the lake. Hydraulic analysis indicates that they would not be inundated as a result of dam failure. However, loss of life is possible.

Potential Economic Loss:

An earth dam is located 2000 feet downstream. Failure of Amwell No. 2 Dam could cause failure of downstream dam and damage to road bridge located 2500 feet downstream from dam in question.

Therefore, Amwell No. 2 is classified as "Small" size and "Significant" hazard potential.

d. Ownership

Amwell No. 2 Dam is owned and maintained by Amwell Valley Land Corp., 80 Park Street, Montclair, New Jersey 07042.

e. Purpose of Dam

The purpose of the dam is the impoundment of a lake for recreation.

f. Design and Construction History

Amwell No. 2 Dam reportedly was constructed in 1920 to 1923. In 1955 it was reportedly washed out and subsequently rebuilt. No records of the original construction or the reconstruction in 1955 are available.

g. Normal Operational Procedures

Reportedly, no regular maintenance or operational procedures are performed. The lake does not appear to have an outlet works and reportedly was never drawn down.

1.3 Pertinent Data

a. Drainage Area	0.9 square miles
b. Discharge at Damsite	
Maximum flood at damsite	Unknown
Outlet works at normal pool elevation	No known outlet
Spillway capacity at top of dam (Elev. 170.0)	223 c.f.s.
c. Elevation (N.G.V.D.)	
Top of dam	170.0
Maximum pool - design surcharge	171.4

Normal pool	167.5
Spillway crest - primary	167.5
- secondary	167.9
Toe of dam	150.8
Maximum tailwater	Unknown

d. Reservoir

Length of maximum pool	2500 feet
Length of normal pool	2100 feet

e. Storage (Acre-feet)

Spillway crest	69 acre-feet
Design surcharge	131 acre-feet
Top of dam (Elev. 170.0)	106 acre-feet

f. Reservoir Surface (Acres)

Spillway crest	11.9 acres
Top of dam (Elev. 170.0)	13.1 acres
Maximum pool - design surcharge	23.1 acres

g. Dam

Type	Earthfill
Length	285 feet
Hydraulic Height	19.2 feet
Side slopes - Upstream	Unknown
Downstream	1.5 horiz. to 1 vert.
Zoning	Unknown
Impervious core	Unknown
Cutoff	Unknown
Grout curtain	Unknown

h. Diversion and Regulating Tunnel — N.A.

i. Spillway

Type	Uncontrolled concrete overflow weir
Length of weir - primary	8 feet
- secondary	12 feet
Crest elevation - primary	167.5
- secondary	167.9
Gates	N.A.
Upstream channel	N.A.
Downstream channel	Natural stream

J. Regulating outlets

None Known

SECTION 2: ENGINEERING DATA

2.1 Design

No calculations, reports or plans pertaining to the design of the dam are available.

2.2 Construction

No data or reports pertaining to the construction of the dam are available.

2.3 Operation

No records of operation and maintenance of the dam subsequent to construction are available.

2.4 Evaluation

a. Availability

No engineering data pertaining to the dam is available.

b. Adequacy

A list of absent information is included in paragraph 7.1.b.

c. Validity

The validity of engineering data cannot be assessed due to the absence of data.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The inspection of Amwell No. 2 Dam took place on November 19, 1979 by members of the staff of Storch Engineers. A copy of the visual inspection check-list is contained in Appendix 1. The following procedures were employed for the inspection:

1) The embankment of the dam, appurtenant structures and adjacent areas were examined.
2) Areas of seepage were noted and located.
3) The embankment and appurtenant structures were measured and key elevations determined with the use of a surveyor's level.
4) The embankment, appurtenent structures and adjacent areas were photographed.
5) Depths of water were measured at various locations in the lake.

b. Spillway

The concrete free overflow spillway is located at the upstream side of the west end of the dam. It discharges into a rectangular concrete-lined channel located at the west end of the embankment. A concrete slab walkway spans the discharge channel along the crest of the dam. The concrete surfaces of the notched overflow spillway appear to be in satisfactory condition. Concrete surfaces of the discharge channel appeared to be in fair condition with some large cracks noted. The left training wall at the downstream end of the discharge channel was

tilted into the channel. The spillway discharge channel was observed to be partly obstructed by fallen trees and rotted timbers that had spanned the channel. The timbers did not appear to be a structural component of the discharge channel.

c. Embankment

The embankment is severely overgrown with trees and brush. The crest of embankment is fairly uniform and covered with grass and weeds. The upstream face is covered with brush and trees. The downstream face is covered with grass, weeds and trees varying in caliper up to 18 inches. Two points of seepage, one near each end of the embankment, were observed. Discharge was measured to be approximately 1-1/2 gallons per minute at one point on the downstream face near the west end and approximately 1 gallon per minute at the toe at the east end. Small streams carrying seepage water away from these points appear to indicate that seepage has been discharging for a significant length of time.

The concrete wall on the upstream face of the dam appears to be in generally satisfactory condition. A rough edge was observed along the wall 1-1/2 feet below its top. This could be due to forming at the time of construction. Transverse cracks were observed along the wall at 15 to 20 foot intervals.

Erosion was noted on the downstream face adjacent to the spillway discharge channel. A three-foot high mound of earth was observed at the toe near the center of the dam. The mound could be due to sloughing of the downstream face of embankment.

d. Reservoir Area

The shores of Amwell No. 2 Lake are generally wooded and have an average slope of approximately 5 horizontal to 1 vertical.

e. Downstream Channel

The spillway discharges directly into a tributary of Alexauken Creek which is a well defined stream. Approximately 300 feet downstream it enters a lake impounded by an earth dam approximately 17 feet high. Several dwellings are located on the shore of the lower lake approximately 2000 feet from the subject dam. A road bridge crosses the stream approximately 2500 feet downstream from the dam in question.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

The level of water in Amwell Lake No. 2 is regulated naturally by discharge over the spillway of the dam. No outlet works are reported to exist and none were observed during inspection.

4.2 Maintenance of the Dam

According to the owner and tenant of the property, there is no program of regular maintenance of the dam and appurtenant structures. The last known maintenance was performed in 1955 after the dam was washed out.

4.3 Maintenance of Operating Facilities

Reportedly, there is no program of regular maintenance of the operating facilities.

4.4 Description of Warning System

Reportedly, no formal warning system is in use at the present time.

4.5 Evaluation of Operational Adequacy

The apparent absence of a functioning outlet works and a maintenance program contributes to a poor operational adequacy of the dam.

The dam was observed to be insufficiently maintained in the following areas:

1) Trees and brush on embankment.
2) Extensive seepage.
3) Debris and fallen trees at spillway discharge channel.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The quantity of storm water runoff that the spillway should be able to pass without an overtopping of the dam is based on the size and hazard classification of the dam. This runoff, called the Spillway Design Flood (SDF), is described in terms of frequency or Probable Maximum Flood (PMF) depending on the extent of the dam size and potential hazard. According to the "Recommended Guidelines for Safety Inspection of Dams," published by the U.S. Army Corps of Engineers, the SDF for Amwell No. 2 Dam falls in a range of 100-year frequency to 1/2 PMF. In this case the high end of the range, 1/2 PMF, is chosen because of the hazard potential associated with the downstream dam and road.

The SDF hydrograph for Amwell No. 2 Dam was computed by use of the HEC-1-DB computer program using SCS triangular hydrograph with the curvelinear transformation. Hydrologic computations and computer output are contained in Appendix 4. The calculated SDF peak inflow for Amwell No. 2 Dam is 1731 c.f.s.

Discharge capacity for the spillway was computed by considering free discharge over the concrete spillway. Hydraulic computations are contained in Appendix 4.

The elevation of the crest of dam varies from 170.0 to 171.0. For purposes of computer input, the top of dam was taken as 170.0. A routing of the SDF through Amwell No. 2 Dam

resulted in an overtopping of the dam by a depth of 1.4 feet. Accordingly, the subject spillway is assessed as being inadequate in accordance with criteria developed by the U.S. Army Corps of Engineers.

b. Experience Data

Reportedly, the dam was overtopped and washed out in 1955 and was rebuilt with a very steep downstream slope. Since then no overtopping has been reported.

c. Visual Observation

No evidence of recent overtopping was found at the time of inspection.

d. Overtopping Potential

As indicated in Paragraph 5.1.a., a storm of magnitude equivalent to the SDF would cause overtopping of the dam by a height of 1.4 feet above the top of the dam. The spillway is capable of passing approximately 9 percent of PMF and 18 percent of SDF with lake level equal to the top of the dam (Elev. 170.0).

e. Drawdown Data

No drawdown computations can be performed due to the apparent lack of outlet works.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The embankment appeared, at the time of inspection to be outwardly stable. However two points of significant of seepage were observed on the downstream side. Also, the slope of the downstream face of embankment was found to be excessively steep and a mound of earth was noted at its toe. An accurate determination of the structural integrity of the embankment cannot be made without further investigation beyond the scope of a Phase I inspection.

b. Generalized Soils Description

The generalized soils description of the dam site consists of recent alluvium composed of stratified materials deposited by streams. The alluvium overlies thin beds of soft shale, colored dull red, with occasional interstratified beds of fine grained sandstone, all dipping gently toward the northwest. The shale bedrock breaks easily into small fragments 1/4" to 1-1/2" in size and is identified as Brunswick shale.

c. Design and Construction Data

Design analysis of structural stability and construction data for the embankment and spillway structure are not available.

d. Operating Records

No operating records relating to structural stability of the dam are available.

e. Post Construction Changes

Reportedly, after the washout in 1955, the dam was rebuilt with a downstream slope of 1.5 horizontal to 1 vertical. However, no records are available.

f. Seismic Stability

Amwell No. 2 Dam is located in Seismic Zone 1 as defined in "Recommended Guidelines for Safety Inspection of Dams," which is a zone of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions if stable under static loading conditions. However, Amwell No. 2 Dam, which exhibits extensive seepage and other indications of possible distress, could be unstable under seismic loading conditions.

SECTION 7: ASSESSMENT AND RECOMMENDATIONS

7.1 Dam Assessment

a. Safety

Based on hydraulic and hydrologic analyses outlined in Section 5 and Appendix 4, the spillway of Amwell No. 2 Dam is assessed as being inadequate.

The embankment exhibits extensive seepage and possible sloughing on the downstream face. The condition of the dam indicates that the embankment would become unstable if corrective measures are not implemented.

b. Adequacy of Information

Information sources for this study include 1) field inspection, 2) USGS quadrangle, 3) aerial photography, 4) consultation with property leasee. The information outlined is sufficient to allow a Phase I assessment as outlined in "Recommended Guidelines for Safety Inspection of Dams."

Some of the absent data are as follows:

1) Soils Report
2) Plans of the dam
3) Structural Design Report
4) Hydraulic Design Report
5) Reports of post construction
6) Maintenance documentation

c. Necessity for Additional Data/Evaluation

Additional data and evaluation is considered necessary in order to assess the structural integrity of the dam.

7.2 Recommendations

a. Remedial Measures

Based on hydraulic and hydrologic analyses outlined in paragraph 5.1.a., the spillway is assessed as being inadequate. It is therefore recommended that a professional engineer experienced in the design and construction of dams be engaged in the near future to perform more accurate hydraulic and hydrologic analyses. Based on the findings of these analyses, the need for and type of remedial measures should be determined and then implemented.

The owner should, in the near future, develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

The embankment should be thoroughly inspected soon by a professional engineer experienced in the design and construction of dams. Based on the inspections, together with any necessary subsoil, seepage and structural investigations, remedial measures to correct the seepage and other possible causes of embankment instability, including the steep downstream slope and mounded soil at the toe, should be determined and implemented.

In addition, it is recommended that the following remedial measures be undertaken by the owner in the near future.

1) If it exists, the outlet works should be investigated and restored to a functional condition. If no outlet works exist, an adequate low level lake drain should be designed and installed.

2) All adverse vegetation on the embankment should be removed and animal holes filled.

3) Debris in the spillway discharge channel should be removed.

4) The left training wall of the spillway discharge channel should be repaired or replaced.

b. Maintenance

In the near future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to insure the safety of the dam.

c. Additional Studies

A detailed topographic survey of the dam and area around the dam based on N.G.V.D. should be undertaken by a qualified licensed land surveyor or professional engineer in the near future. The survey map should become part of the permanent record mentioned in paragraph 7.2.b.

PLATES

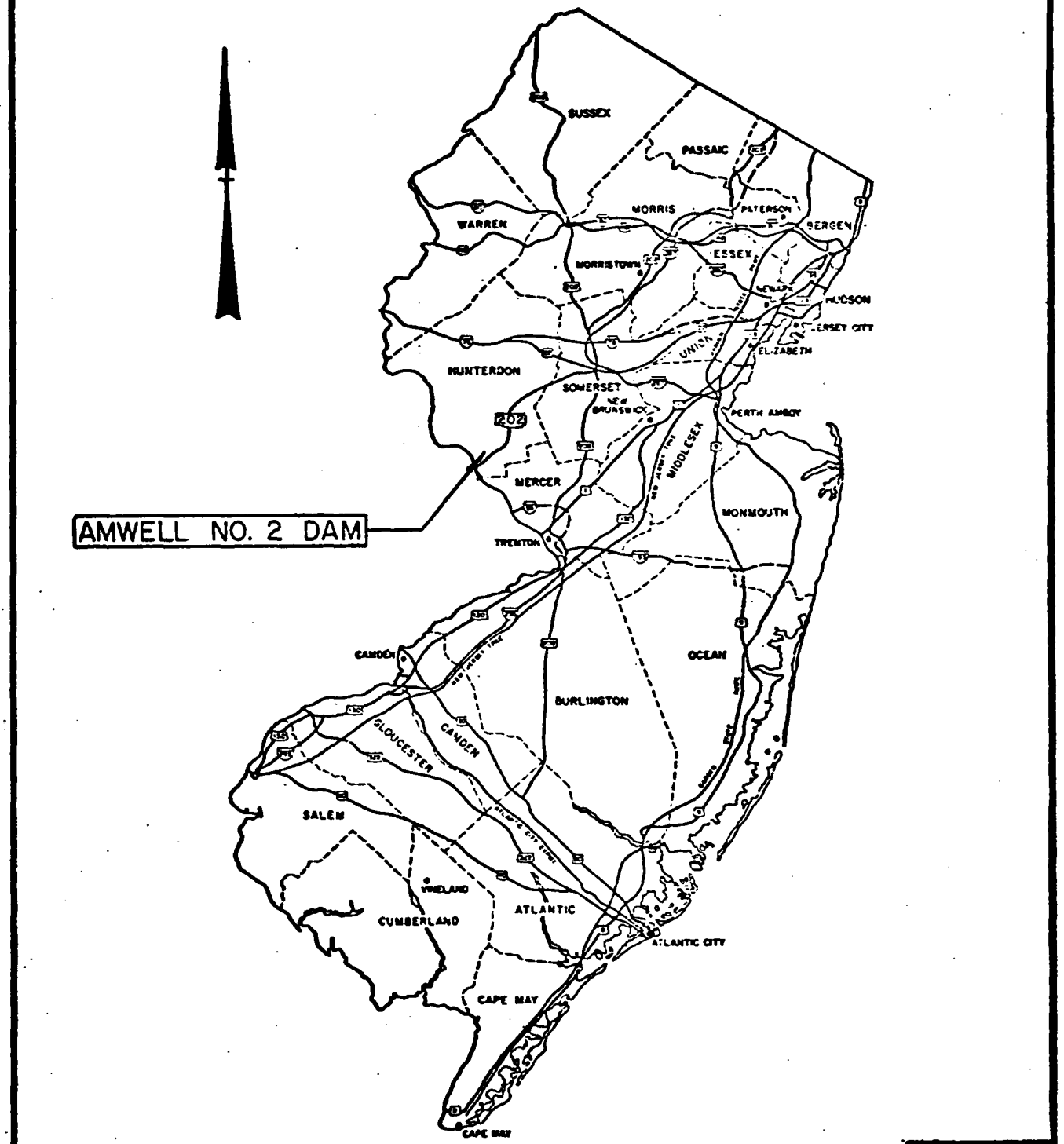
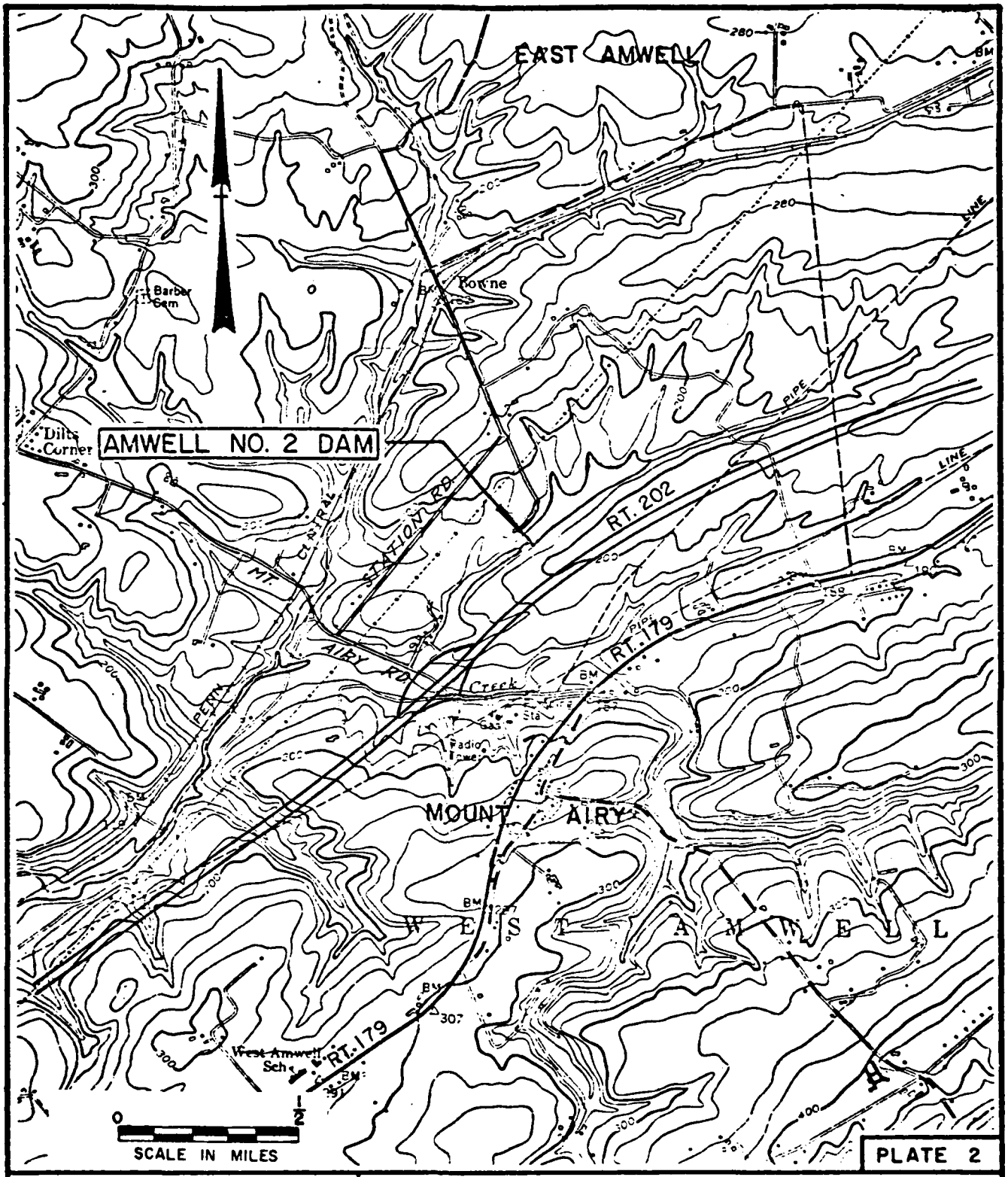
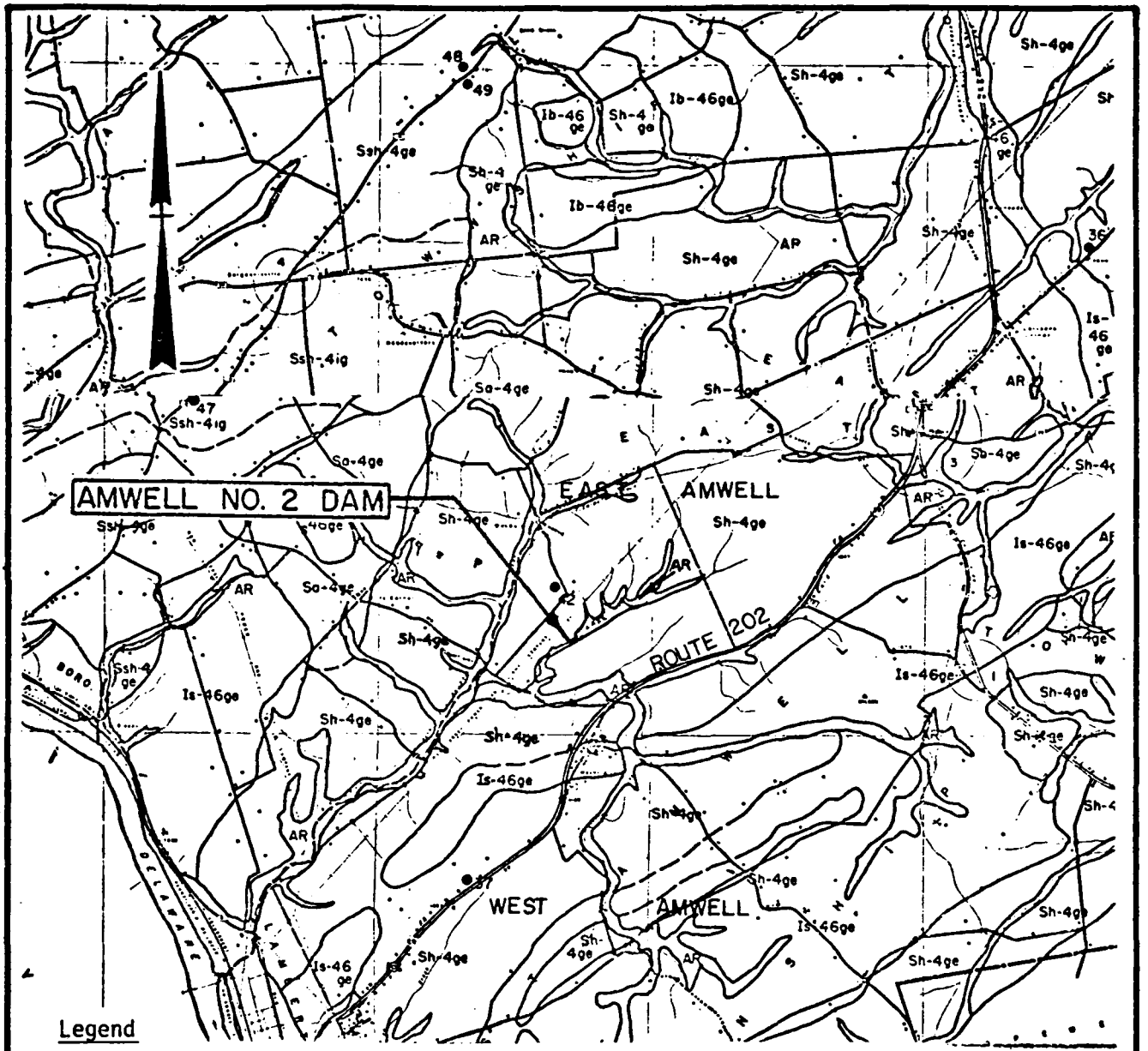


PLATE 1

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS KEY MAP AMWELL NO. 2 DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D.N.J. 00522 — SCALE: NONE DATE: NOV., 1979



STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS VICINITY MAP AMWELL NO. 2 DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D. N.J. 00522 — SCALE: AS SHOWN DATE: NOV., 1979



Legend

AR — Recent alluvium composed of stratified materials deposited by streams.

Sh-4 — Silts with silty clays in the depressions overlying thin beds of soft shale colored dull red.

NOTE: Information taken from Rutgers University Soil Survey of New Jersey, Report No. 6, Hunterdon County, and Geologic Map of New Jersey prepared by Lewis and Kummel.

PLATE 3

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

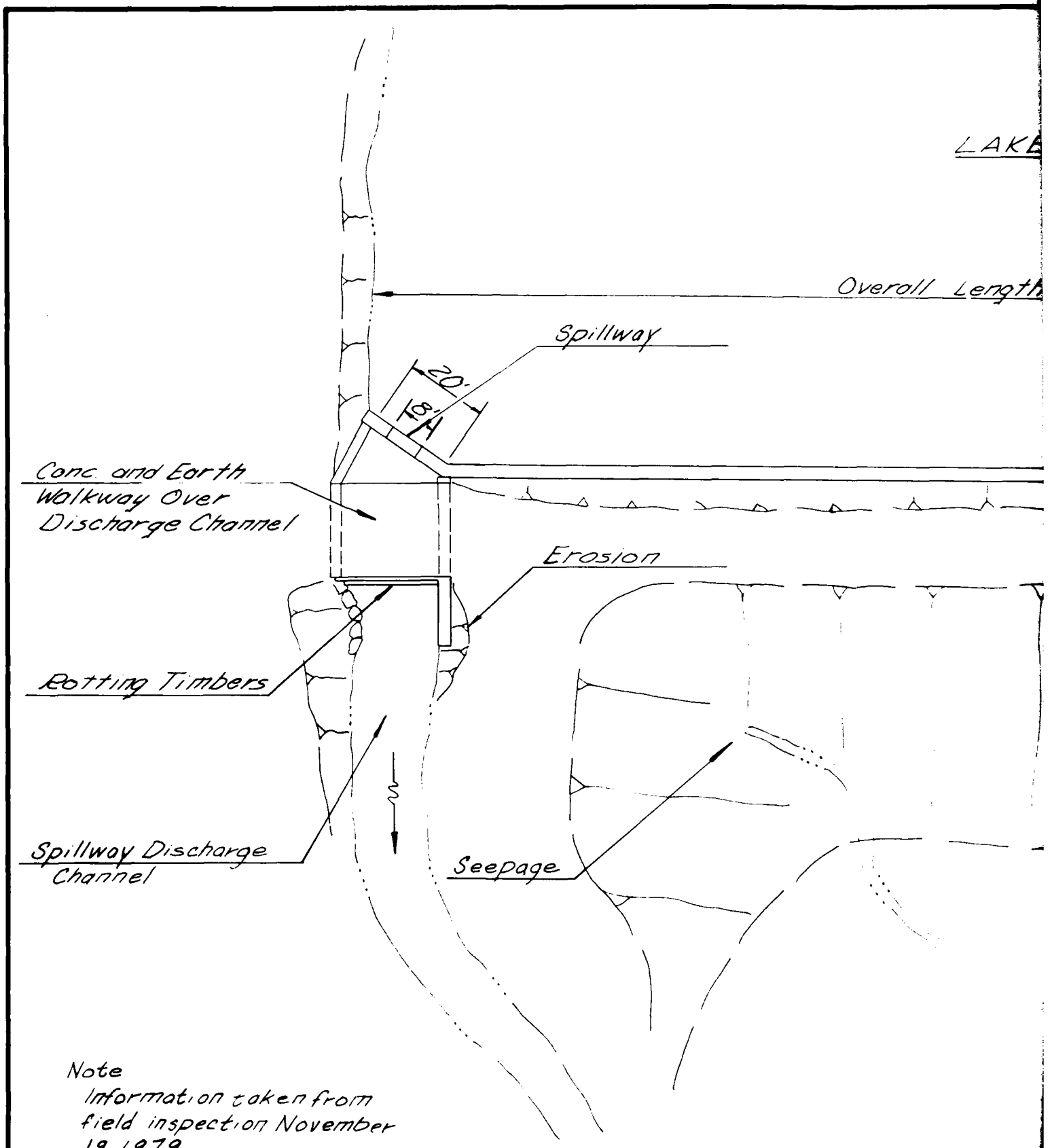
SOIL MAP

AMWELL NO. 2 DAM

I.D. NJ00522

SCALE: NONE

DATE: NOV., 1979



Note
Information taken from field inspection November 19, 1979.

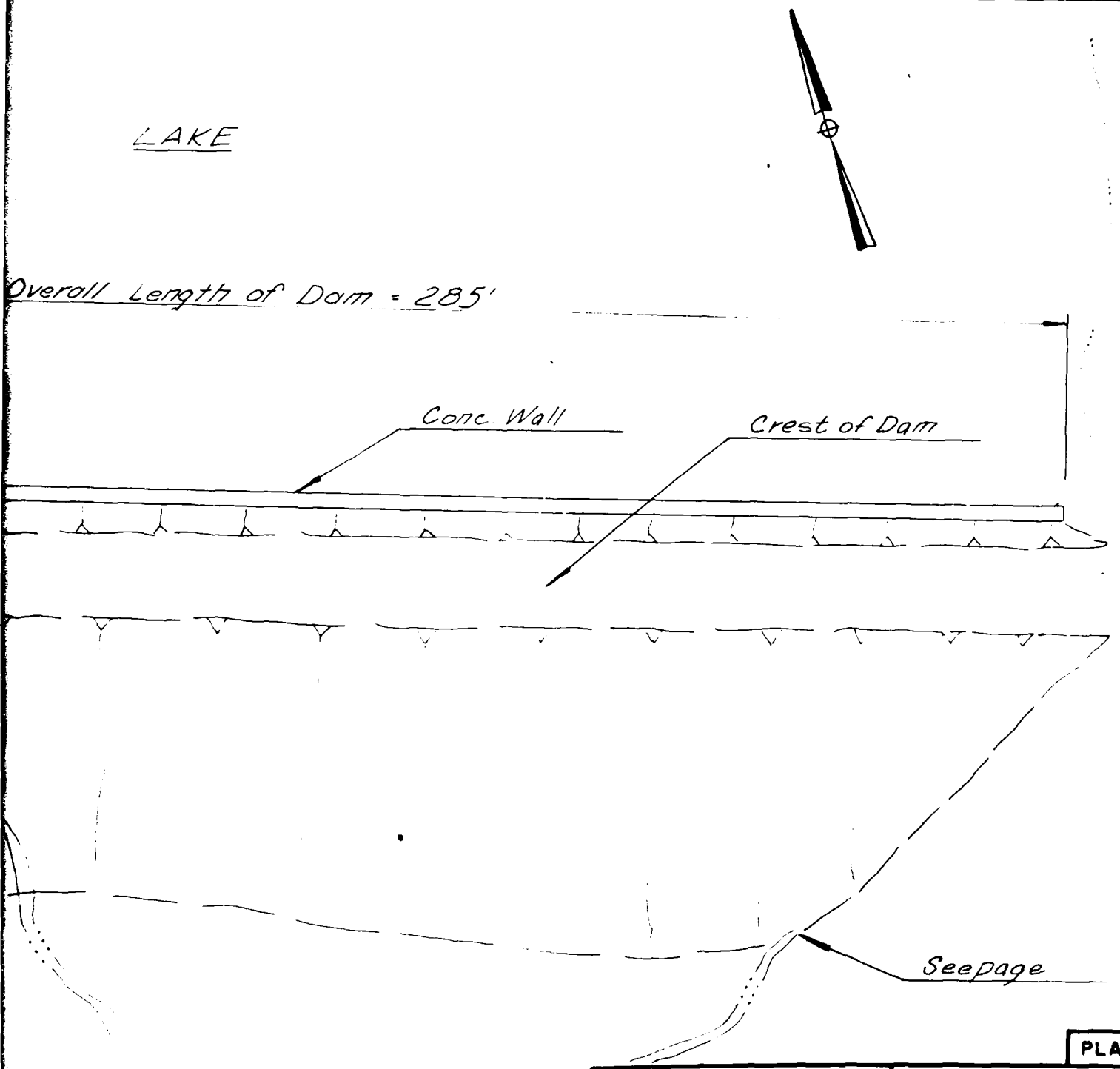


PLATE 4

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

GENERAL PLAN

AMWELL NO. 2 DAM

I.D.N.J. 00522	SCALE: NOT TO SCALE
	DATE: JAN. 1980

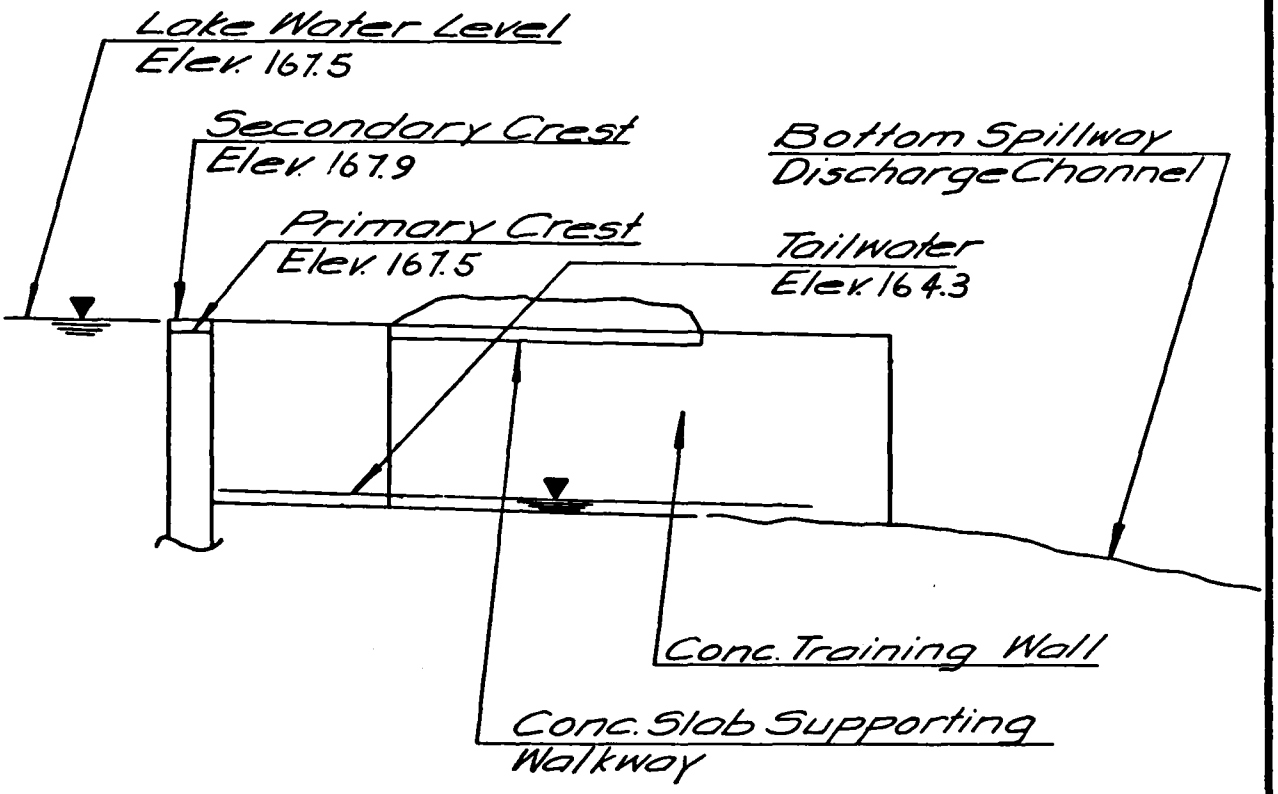


PLATE 5

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS SPILLWAY SECTION AMWELL NO.2 DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D.N.J. 00522 — SCALE: NOT TO SCALE DATE: JAN. 1980

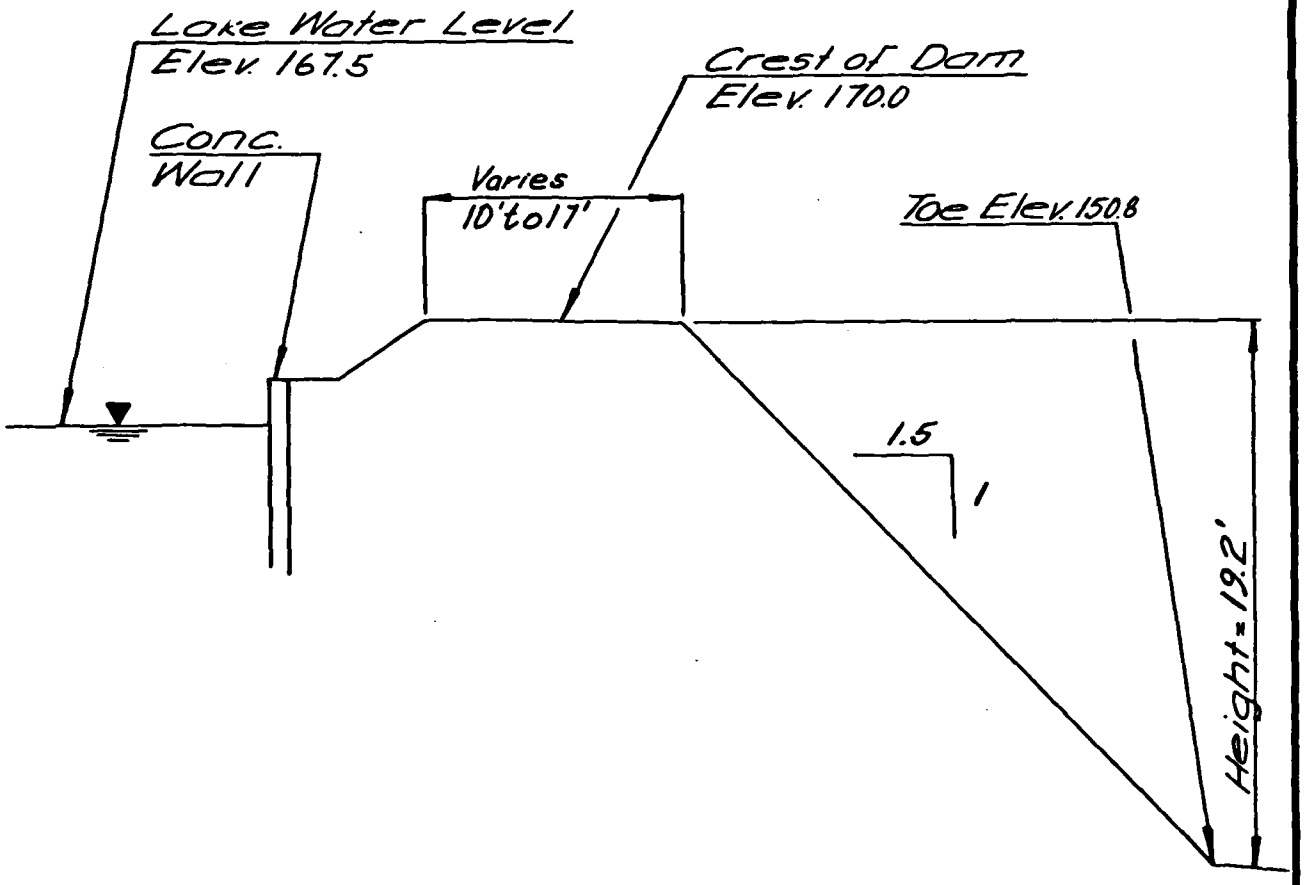
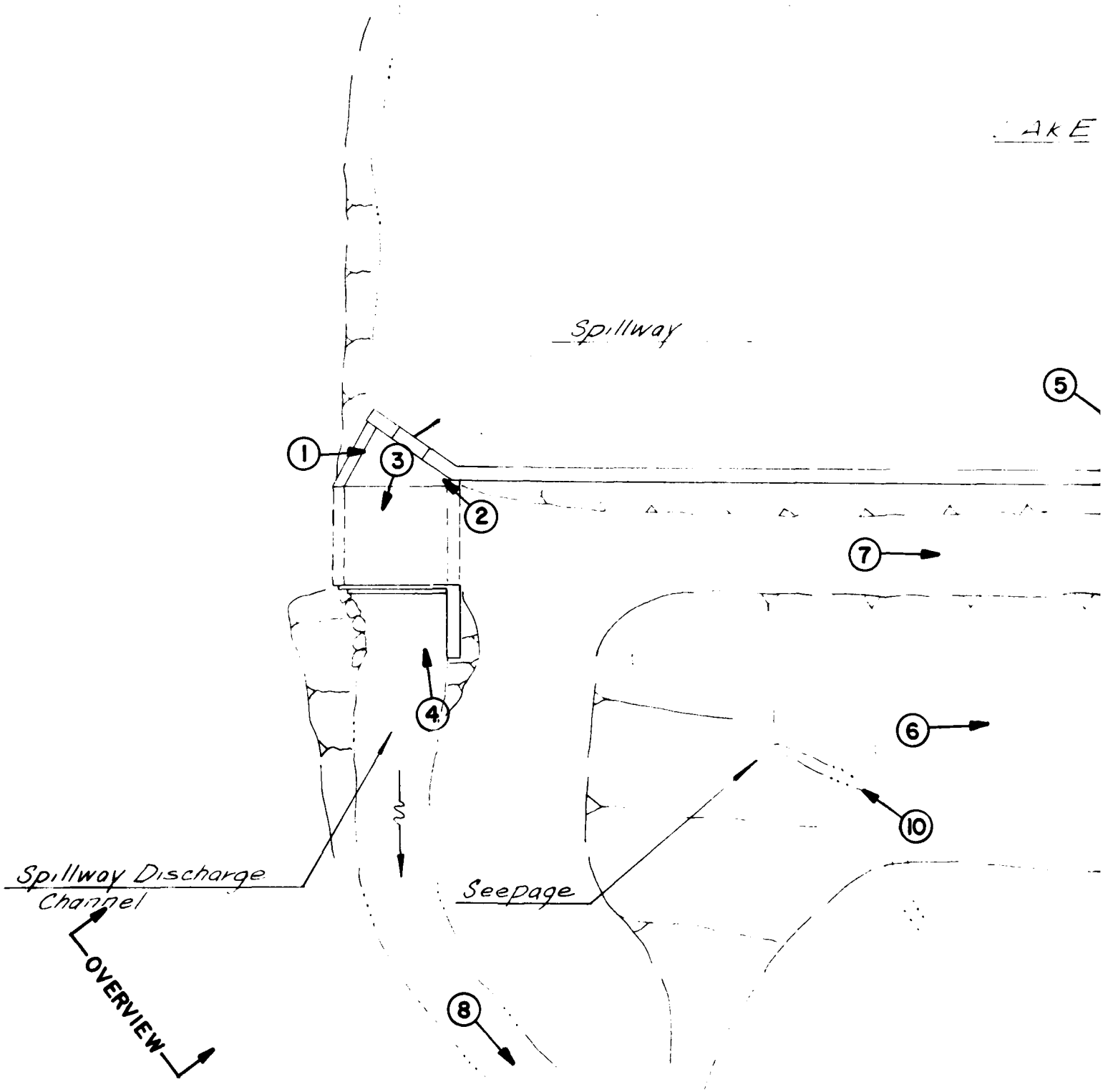


PLATE 6

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS DAM SECTION AMWELL NO.2 DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D. N.J. 00522 — SCALE: NOT TO SCALE DATE: JAN. 1980



Note
Information taken from field inspection on November 19, 1979

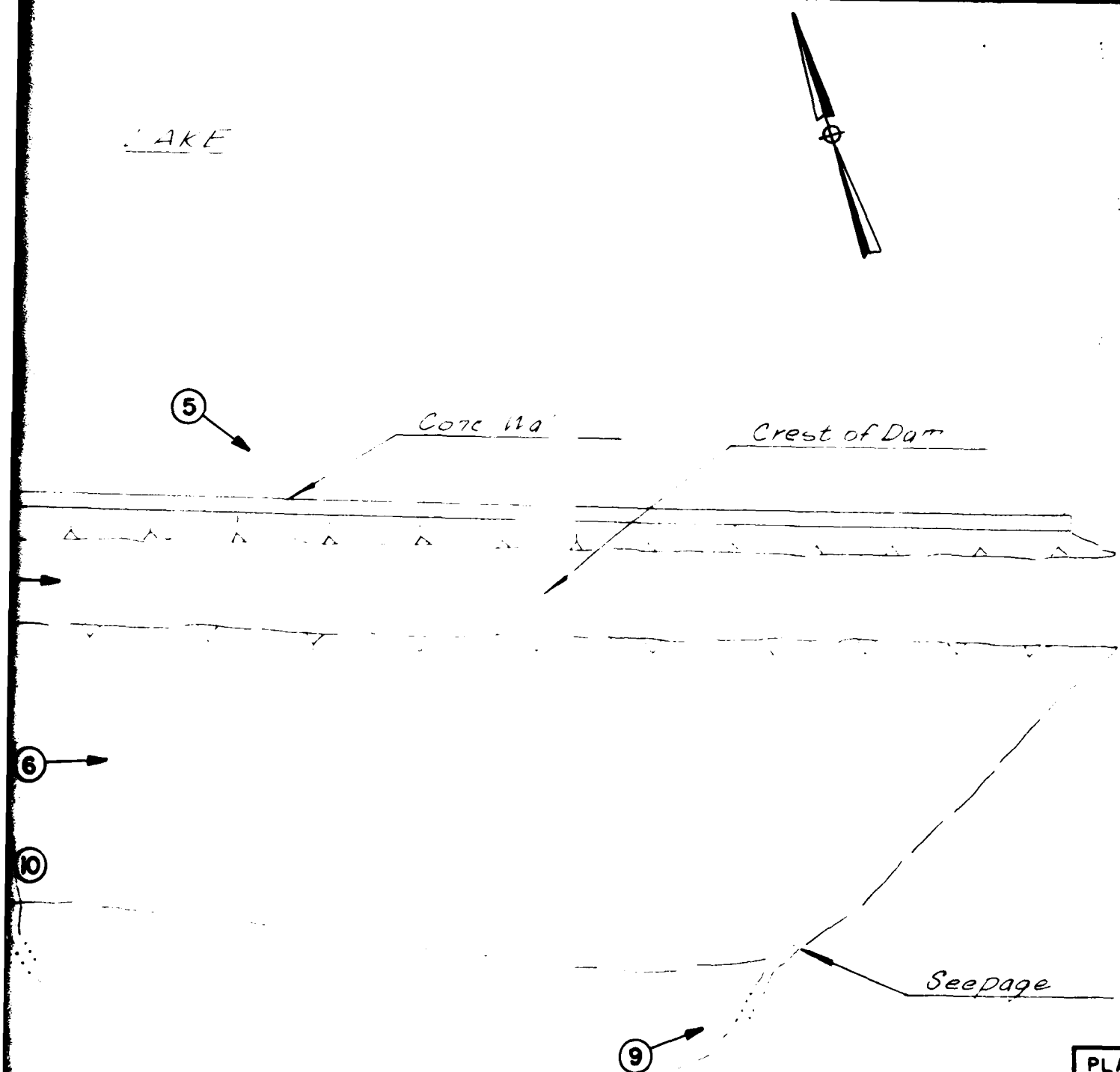


PLATE 7

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

PHOTO LOCATION PLAN

AMWELL NO. 2 DAM

I.D.N.J. 00522	SCALE NOT TO SCALE
	DATE JAN. 1980

APPENDIX 1

Check List - Visual Inspection
Check List - Engineering Data

Check List
Visual Inspection
Phase I

Name of Dam Amwell No. 2 Dam County Hunterdon State New Jersey Coordinators NJDEP

Date(s) Inspection 11/19/79 Weather P-Cloudy Temperature 60°F

Pool Elevation at Time of Inspection 167.5 M.S.L. Tailwater at Time of Inspection 164.3 M.S.L.

Inspection Personnel:

John Gribbin	Alan Volle	
Ronald Lai	Thomas Miller	
Richard McDermott		

J. Gribbin Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
GENERAL	Embankment extensively overgrown with trees and brush. Narrow foot path on crest. Trees vary in caliper up to 18 inches. Some animal holes noted.	Recommend removal of trees and brush and filling of animal holes.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Significant erosion noted at downstream side of concrete spillway discharge structure.	Recommend stabilizing eroded area.
ANY NOTICEABLE SEEPAGE	Two points of seepage noted on downstream side of embankment; one on the downstream face near the west end of the dam discharging at about 1.5 gal./min.; the other at the toe at the east end of the dam discharging at about 1 gal./min.	Recommend seepage investigation.
STAFF GAGE AND RECORDER	None	
DRAINS	None observed.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	3-foot high mound observed at toe at approx. center of dam.	This could be due to movement or sloughing.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Possible sloughing at toe (see note above). Erosion noted on embankment adjacent to spillway discharge channel.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical: generally level Horizontal: generally straight Downstream face very steep: approx. 1 vert to 1.5 horiz. slope	
CONC. WALL	Concrete surfaces in generally satisfactory condition with some spalling. A rough edge is located along the wall 18 inches below the top - appears to be related to forming. Transverse cracks noted at 15 to 20 foot intervals, 1/8 to 1/4 inch wide.	Conc. wall forming upstream face could be protruding core wall.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES IN OUTLET CONDUIT	N.A.	No low level outlet observed.
INTAKE STRUCTURE	N.A.	
OUTLET STRUCTURE	N.A.	
OUTLET CHANNEL	N.A.	
GATE AND GATE HOUSING	N.A.	

SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONC. WEIR	Concrete surfaces in generally satisfactory condition. Debris observed on crest.	
APPROACH CHANNEL	N.A.	
DISCHARGE CHANNEL	Concrete surfaces generally fair with some large cracks noted. Left training wall at downstream end of channel was leaning toward right end of dam.	
WALKWAY	Concrete surfaces in generally satisfactory condition. Timbers on downstream side were rotted and broken and partially obstructing discharge channel.	Concrete slab walkway spans spillway discharge channel. Slab supports earth graded flush with crest of embankment. Recommend renovation or removal of timbers.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	N.A.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Banks are generally wooded. Slope of south bank about 7:1, slope of north bank about 20:1.	
SEDIMENTATION	Soundings at the downstream end of the lake indicate little accumulation of sediment.	
STRUCTURES ALONG BANKS	Lake is undeveloped. No structures observed along the banks.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Downstream channel consists of 300-foot long stream discharging into a lake downstream from the dam. Stream contains little obstruction; but discharge channel is obstructed immediately downstream from spillway.	
SLOPES	Slopes of the stream banks are generally steep (5 horiz. to 1 vert.) and wooded.	
STRUCTURES ALONG BANKS	A few dwellings are located along the north shore of the downstream lake. A road bridge is located on the downstream channel of the lower lake approx. 2500 feet from the dam in question.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
DAM - PLAN	Not Available
SECTIONS	
SPILLWAY - PLAN	Not Available
SECTIONS	
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	Not Available
OUTLETS - PLAN	Not Available
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	
HYDRAULIC/HYDROLOGIC DATA	Not Available
RAINFALL/RESERVOIR RECORDS	Not Available
CONSTRUCTION HISTORY	Not Available
LOCATION MAP	Not Available

ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Not Available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not Available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Not Available
POST-CONSTRUCTION SURVEYS OF DAM	Not Available
BORROW SOURCES	Not Available

ITEM	REMARKS
MONITORING SYSTEMS	None known
MODIFICATIONS	Not Available
HIGH POOL RECORDS	Not Available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Not Available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Dam reportedly washed out in 1955. Written reports not available.
MAINTENANCE OPERATION RECORDS	Not available

APPENDIX 2

Photographs

PHOTO 1

SPILLWAY CREST - LOOKING EAST

PHOTO 2

SPILLWAY CREST - LOOKING WEST

AMWELL NO. 2 DAM
9 NOVEMBER 1979

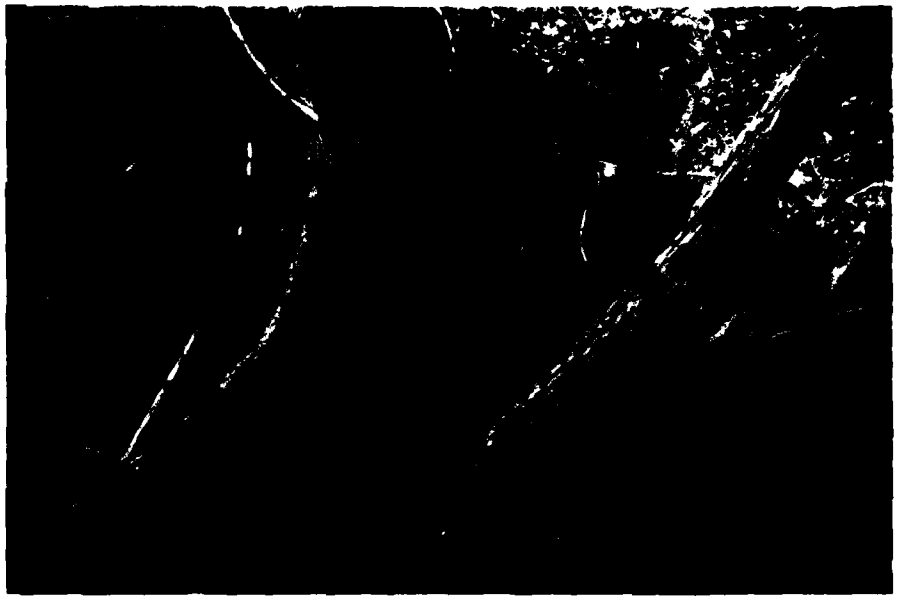


PHOTO 3

SPILLWAY DISCHARGE CHANNEL - UPSTREAM VIEW

PHOTO 4

SPILLWAY DISCHARGE CHANNEL - DOWNSTREAM VIEW

AMWELL NO. 2 DAM
9 NOVEMBER 1979

PHOTO 5

CONCRETE WALL ALONG UPSTREAM FACE OF DAM

PHOTO 6

DOWNSTREAM FACE OF DAM

AMWELL NO. 2 DAM
9 NOVEMBER 1979

PHOTO 7

CREST OF DAM

PHOTO 8

DOWNSTREAM CHANNEL

AMWELL NO. 2 DAM
9 NOVEMBER 1979

PHOTO 9

SEEPAGE AT TOE OF DAM - EAST END

PHOTO 10

SEEPAGE ON DOWNSTREAM FACE OF DAM NEAR SPILLWAY

AMWELL NO. 2 DAM
9 NOVEMBER 1979

PHOTO 9

SEEPAGE AT TOE OF DAM - EAST END

PHOTO 10

SEEPAGE ON DOWNSTREAM FACE OF DAM NEAR SPILLWAY

AMWELL NO. 2 DAM
9 NOVEMBER 1979

APPENDIX 3

Engineering Data

CHECK LIST

HYDROLOGIC AND HYDRAULIC DATA

ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: wooded, moderately steep terraine

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 167.5 (69 Acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N.A.

ELEVATION MAXIMUM DESIGN POOL: 171.4

ELEVATION TOP DAM: Varies 170.0 to 171.0

SPILLWAY CREST: Straight concrete weir with notch

a. Elevation Primary: 167.5, Secondary: 167.9
b. Type Broad crested
c. Width 1.6 feet
d. Length Primary: 8 feet, Secondary: 12 feet
e. Location Spillover Upstream of dam n/w end
f. Number and Type of Gates None

OUTLET WORKS: None

a. Type N.A.
b. Location N.A.
c. Entrance inverts N.A.
d. Exit inverts N.A.
e. Emergency draindown facilities: N.A.

HYDROMETEOROLOGICAL GAGES: None

a. Type N.A.
b. Location N.A.
c. Records N.A.

MAXIMUM NON-DAMAGING DISCHARGE:

(Lake stage equal to top of dam) 223 c.f.s.
(Elev. 170.0)

APPENDIX 4

Hydraulic/Hydrologic Computations

HYDROLOGY

Hydrologic Analysis

Runoff hydrograph will be developed by HEC-1-DB using triangular hydrograph with the curvilinear transformation.

Drainage area = 0.9 mile^2

Infiltration Data

Initial infiltration	1.5 in
Constant infiltration	0.15 in/hr

Time of Concentration

Vel. of overland flow by chart from SCS TR-55

Distance of overland flow 1,600 ft at 1.8 %

Distance of channel flow 4,500 ft at 0.7 %

$$Tc = \left(\frac{1600}{0.35} + \frac{4500}{1.3}\right)\frac{1}{3600}$$

$$= 2.2 \text{ hr.}$$

Time of Concentration

Kirpich Pg 14-7. "Hand book of Applied Hydrology"

$$T_c = 0.00013 \frac{L^{0.77}}{S^{0.385}}$$

T_c = time of concentration in hrs
L = distance to basin divide
S = average slope

$$T_c = 0.00013 \frac{(6100)^{0.77}}{(0.01)^{0.385}}$$

$$= \underline{\underline{0.63}} \text{ hrs}$$

Time of Concentration

Lag time by Synders Method

$$t_p = C_t (L L_{ca})^{0.3}$$

$$= 2.0 (6100 \times 3000)^{0.3}$$

$$= \underline{\underline{1.76}} \text{ hr}$$

Time of concentration

by Kerby Pg 14-36 "Handbook of Applied Hydrology" Chow ED. McGraw Hill

$$t_c^{2.14} = \frac{2\ Ln}{3\ \sqrt{S}}$$

t_c = time of concentration in minutes

L = Length of overland flow in ft.

S = Slope ft/ft

n = 0.4 roughness coef.

$$t_c^{2.14} = \frac{2}{3}\ \frac{1600\ (0.4)}{\sqrt{0.018}}$$

t_c = 0.72 hr. overland

Channel flow = 0.96 hr

T_c = 0.72 + 0.96

= 1.7 hr

use T_c = 1.7 hr lag = 1 hr.

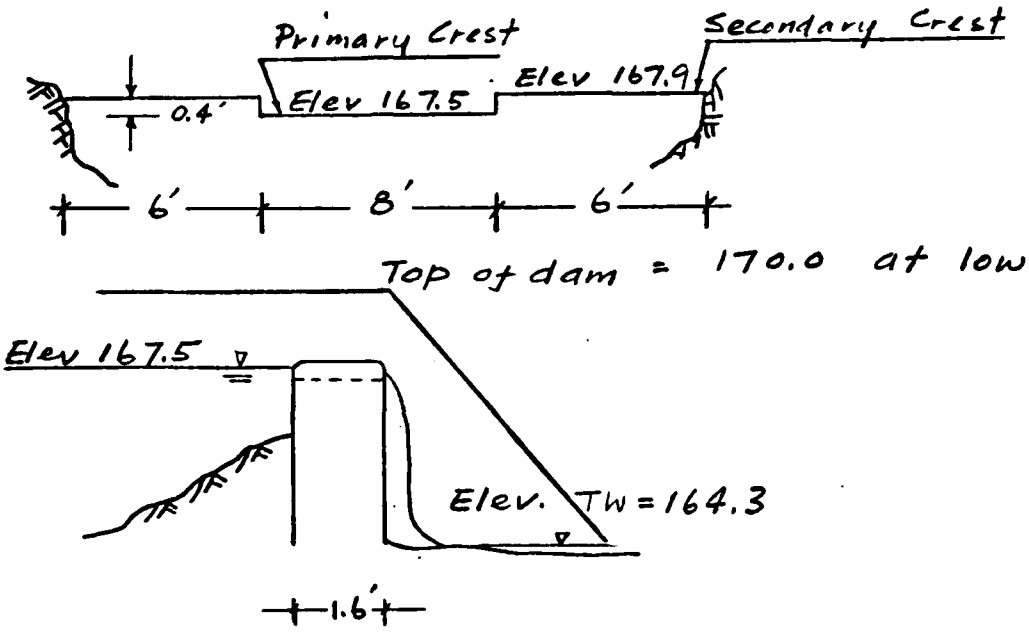
Lake Storage Volume

Elev (MSL)	Surface Area (AC)
148.3	0
167.5	11.9
180.0	47.8
200.0	128.6
220.0	252.5

HEC-1-DB will develope storage capacity from surface area & elev.

Surface areas taken from USGS quadrangle.

HYDRAULICS



SPILLWAY SECTIONS

$Q = CLH^{3/2}$

C values Pg 5-40
"Handbook of Hydraulics"
King Et. al.

Length of spillway Primary 8'
Secondary 12'

Sample Calculation

$H = 3'$ Primary

$Q = 3.3 \times 8 \times 3^{3/2}$
$= 137.2$ cfs

$H_1 = 2.6'$ Secondary

$Q_1 = 3.3 \times 12 \times 2.6^{3/2}$
$= 166$ cfs

$\Sigma Q = 137.2 + 166 = \underline{303.2}$ cfs

STAGE DISCHARGE TABULATION

Primary Crest						Secondary Crest				
W.L. (ft)	H (ft)	$H^{3/2}$	L (ft)	C	Q (cfs)	H_1 (ft)	$H_1^{3/2}$	L_1 (ft)	Q_1 (cfs)	ΣQ (cfs)
167.5	0	0	8	0	0	0	0	12	0	0
167.9	0.4	0.25	8	2.64	5.3	0	0	12	0	5.3
169.0	1.5	1.84	8	3.0	44.2	1.1	1.15	12	41.4	85.6
170.0	2.5	3.95	8	3.28	103.6	2.1	3.04	12	119.7	223.3
171.0	3.5	6.55	8	3.32	174.0	3.1	5.46	12	217.5	391.5
172.0	4.5	9.55	8	3.32	253.6	4.1	8.3	12	330.7	584.3
173.0	55	12.9	8	3.32	342.6	5.1	11.5	12	458.2	800.8
175.0	7.5	20.5	8	3.32	544.5	7.1	18.9	12	753.0	1297.5

STORCH ENGINEERS

Sheet 7 of 8

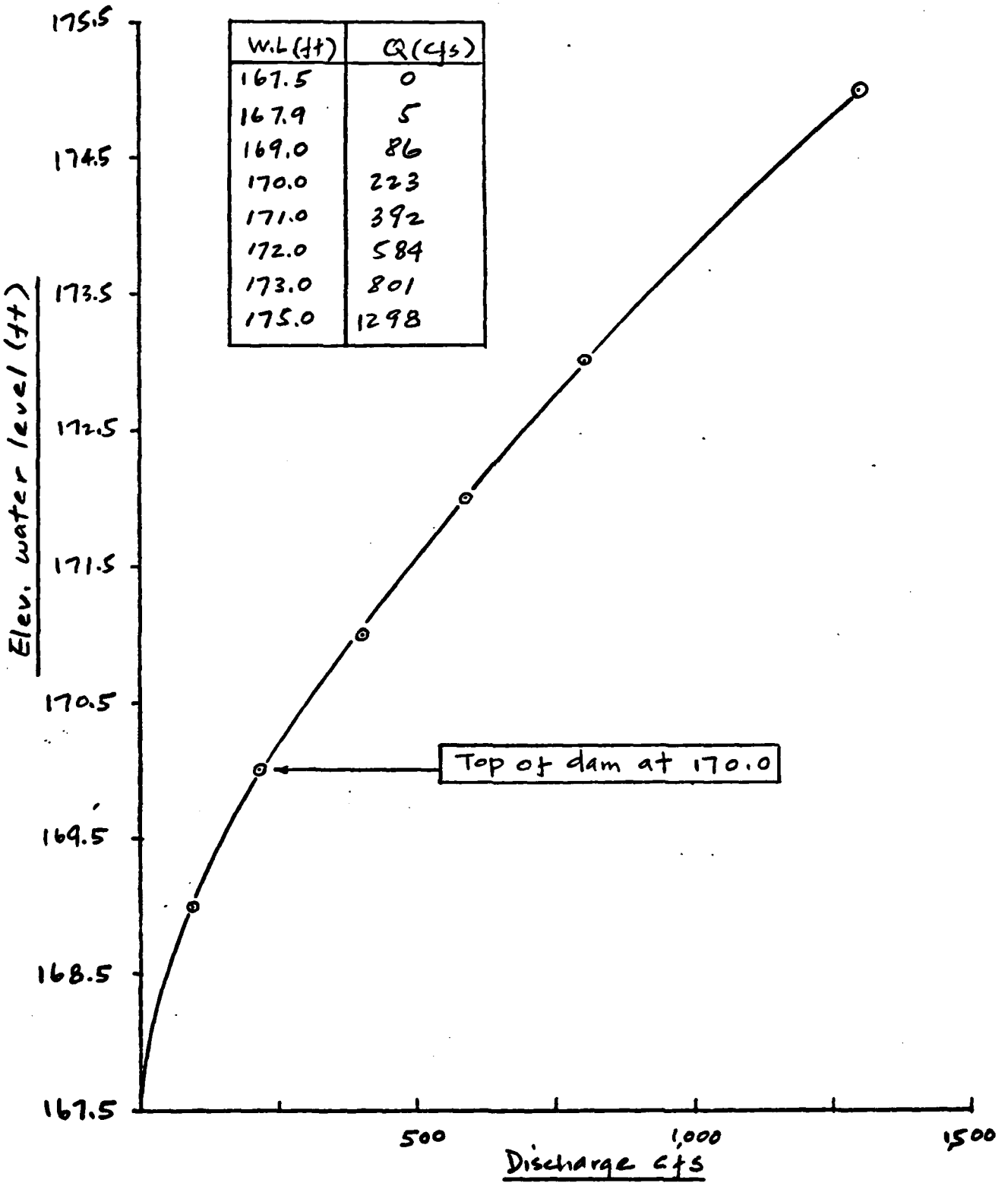
Project Amwell No 2
1132 C

Made By RL Date 1-9-80

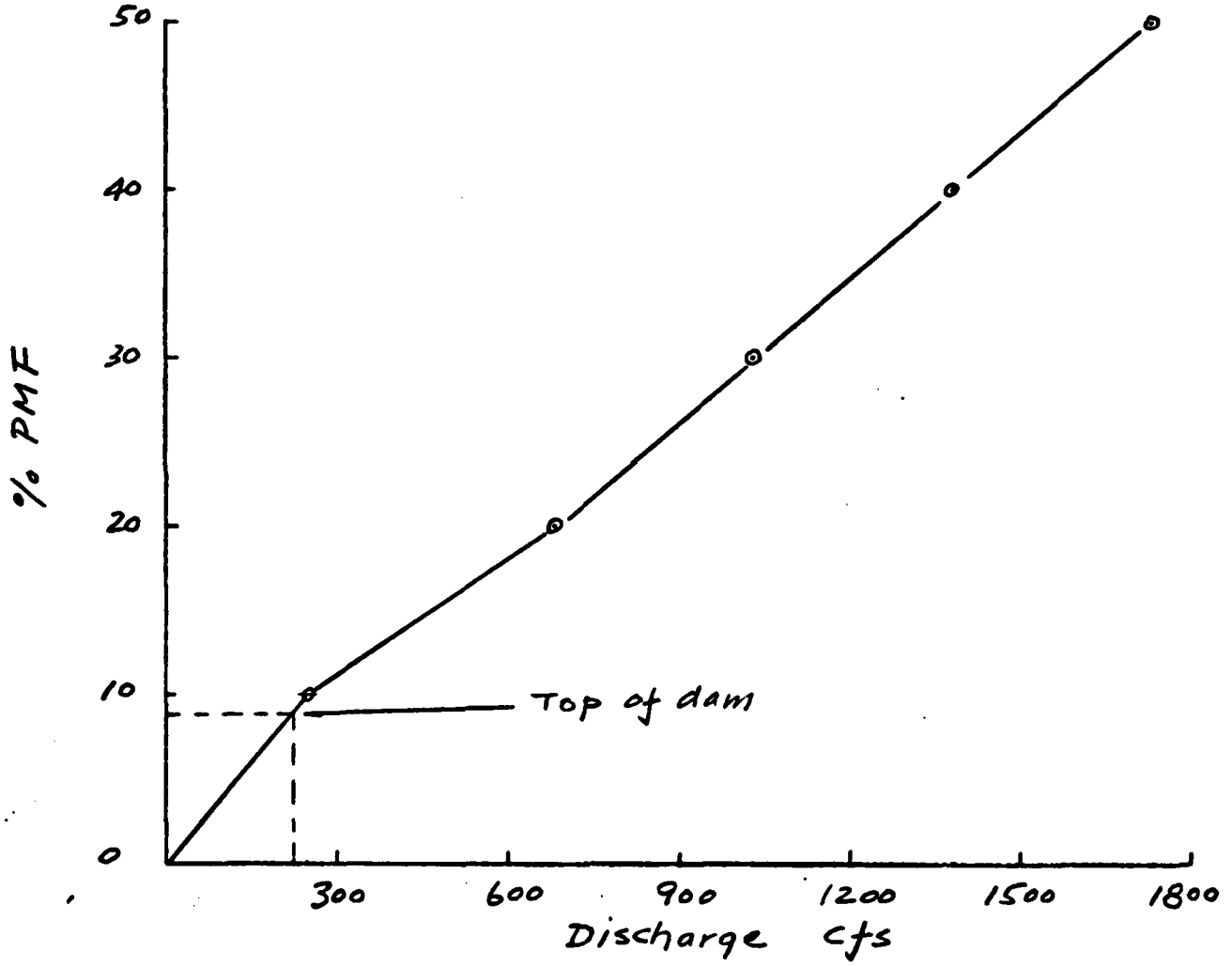
Chkd By JG Date 1/25/80

STAGE DISCHARGE CURVE

W.L (ft)	Q (cfs)
167.5	0
167.9	5
169.0	86
170.0	223
171.0	392
172.0	584
173.0	801
175.0	1298



Overtopping Potential



At top of dam, spillway capacity is 9% of PMF or 18% of SDF

HEC-1-DB COMPUTATIONS

```
A1                          NATIONAL DAM SAFETY PROGRAM
A2                          AMWELL NO. 2 DAM    NEW JERSEY
A3                          MULTI RATIO ROUTING
B       150                 10                                                  3
B1        5
J         1          5      1
J1      0.5        0.4    0.3       0.2       0.1
K                 LAKE                                        1
K1                          SUBAREA INFLOW HYDROGRAPH TO AMWELL NO. 2 LAKE
M         1          2    0.9       0.9                                       1
P                   26    100       109       117
T                                                          1.5       0.15
M2                  1
X      -1.0      -0.05    2.0
K         1         DAM                                             1
K1                          ROUTE DISCHARGE THRU DAM
Y                                     1         1
Y1        1                                                 -167.5        -1
Y4    167.5     167.9     169       170       171       172     173       175
Y5        0         5      86       223       392       584     801      1298
SA        0      11.9    47.8     128.6     252.5
SE      150     167.5     180       200       220
SS    167.5
SD      170      2.63     1.5       285
K        99
A
A
A
A
A
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE# 80/01/09.
     TIME# 14.34.34.

                    NATIONAL DAM SAFETY PROGRAM
                    AMWELL NO. 2 DAM    NEW JERSEY
                    MULTI RATIO ROUTING

                              JOB SPECIFICATION
      NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
     150       0      10       0       0       0       0       0       3       0
                           JOPER     NWT   LROPT   TRACE
                               5       0       0       0

                    MULTI-PLAN ANALYSES TO BE PERFORMED
                              NPLAN= 1 NRTIO= 5 LRTIO= 1
            RTIOS=    .50     .40     .30     .20     .10

**********  **********  **********  **********  **********
                    SUB-AREA RUNOFF COMPUTATION
                    SUBAREA INFLOW HYDROGRAPH TO AMWELL NO. 2 LAKE
                ISTAQ   ICOMP   IECON   ITAPE   JPLT    JPRT   INAME  ISTAGE  IAUTO
                LAKE        0       0       0      0       0       1       0      0
                              HYDROGRAPH DATA
          IHYDG   IUNG   TAREA    SNAP   TRSDA   TRSPC   RATIO  ISNOW  ISAME  LOCAL
              1      2     .90    0.00     .90    0.00   0.000      0      1      0
                              PRECIP DATA
                SPFE     PMS      R6     R12     R24     R48     R72     R96
                0.00   26.00  100.00  109.00  117.00    0.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800
                              LOSS DATA
      LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
          0    0.00    0.00    1.00    0.00    0.00    1.00    1.50     .15    0.00    0.00
                            UNIT HYDROGRAPH DATA
                        TC=  0.00    LAG=  1.00
                              RECESSION DATA
                    STRTQ=   -1.00    QRCSN=    -.05    RTIOR= 2.00
      UNIT HYDROGRAPH 32 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=   1.00  VOL= 1.00
       27.     80.    164.    275.    360.    398.    398.    364.    318.    254.
      188.    145.    112.     90.     70.     54.     42.     33.     25.     20.
       15.     12.      9.      7.      6.      4.      4.      3.      2.      2.
        1.      0.
```

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.10	1	.02	0.00	.02	1.
1.01	.20	2	.02	0.00	.02	1.
1.01	.30	3	.02	0.00	.02	1.
1.01	.40	4	.02	0.00	.02	1.
1.01	.50	5	.02	0.00	.02	1.
1.01	1.00	6	.02	0.00	.02	1.
1.01	1.10	7	.02	0.00	.02	1.
1.01	1.20	8	.02	0.00	.02	1.
1.01	1.30	9	.02	0.00	.02	0.
1.01	1.40	10	.02	0.00	.02	0.
1.01	1.50	11	.02	0.00	.02	0.
1.01	2.00	12	.02	0.00	.02	0.
1.01	2.10	13	.02	0.00	.02	0.
1.01	2.20	14	.02	0.00	.02	0.
1.01	2.30	15	.02	0.00	.02	0.
1.01	2.40	16	.02	0.00	.02	0.
1.01	2.50	17	.02	0.00	.02	0.
1.01	3.00	18	.02	0.00	.02	0.
1.01	3.10	19	.02	0.00	.02	0.
1.01	3.20	20	.02	0.00	.02	0.
1.01	3.30	21	.02	0.00	.02	0.
1.01	3.40	22	.02	0.00	.02	0.
1.01	3.50	23	.02	0.00	.02	0.
1.01	4.00	24	.02	0.00	.02	0.
1.01	4.10	25	.02	0.00	.02	0.
1.01	4.20	26	.02	0.00	.02	0.
1.01	4.30	27	.02	0.00	.02	0.
1.01	4.40	28	.02	0.00	.02	0.
1.01	4.50	29	.02	0.00	.02	0.
1.01	5.00	30	.02	0.00	.02	0.
1.01	5.10	31	.02	0.00	.02	0.
1.01	5.20	32	.02	0.00	.02	0.
1.01	5.30	33	.02	0.00	.02	0.
1.01	5.40	34	.02	0.00	.02	0.
1.01	5.50	35	.02	0.00	.02	0.
1.01	6.00	36	.02	0.00	.02	0.
1.01	6.10	37	.05	0.00	.05	0.
1.01	6.20	38	.05	0.00	.05	0.
1.01	6.30	39	.05	0.00	.05	0.
1.01	6.40	40	.05	0.00	.05	0.
1.01	6.50	41	.05	0.00	.05	0.
1.01	7.00	42	.05	0.00	.05	0.
1.01	7.10	43	.05	0.00	.05	0.
1.01	7.20	44	.05	0.00	.05	0.
1.01	7.30	45	.05	0.00	.05	0.
1.01	7.40	46	.05	0.00	.05	0.
1.01	7.50	47	.05	0.00	.05	0.
1.01	8.00	48	.05	0.00	.05	0.
1.01	8.10	49	.05	0.00	.05	0.
1.01	8.20	50	.05	0.00	.05	0.
1.01	8.30	51	.05	0.00	.05	0.
1.01	8.40	52	.05	0.00	.05	0.
1.01	8.50	53	.05	.03	.03	1.
1.01	9.00	54	.05	.03	.03	3.
1.01	9.10	55	.05	.03	.03	7.
1.01	9.20	56	.05	.03	.03	14.
1.01	9.30	57	.05	.03	.03	24.
1.01	9.40	58	.05	.03	.03	35.
1.01	9.50	59	.05	.03	.03	45.
1.01	10.00	60	.05	.03	.03	55.
1.01	10.10	61	.05	.03	.03	64.
1.01	10.20	62	.05	.03	.03	71.
1.01	10.30	63	.05	.03	.03	76.
1.01	10.40	64	.05	.03	.03	80.
1.01	10.50	65	.05	.03	.03	83.
1.01	11.00	66	.05	.03	.03	86.
1.01	11.10	67	.05	.03	.03	87.
1.01	11.20	68	.05	.03	.03	89.
1.01	11.30	69	.05	.03	.03	90.
1.01	11.40	70	.05	.03	.03	91.
1.01	11.50	71	.05	.03	.03	92.
1.01	12.00	72	.05	.03	.03	92.
1.01	12.10	73	.35	.32	.03	101.
1.01	12.20	74	.35	.32	.03	125.
1.01	12.30	75	.35	.32	.03	173.

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	12.40	76	.35	.32	.03	254.
1.01	12.50	77	.35	.32	.03	360.
1.01	13.00	78	.35	.32	.03	478.
1.01	13.10	79	.42	.39	.03	597.
1.01	13.20	80	.42	.39	.03	710.
1.01	13.30	81	.42	.39	.03	815.
1.01	13.40	82	.42	.39	.03	909.
1.01	13.50	83	.42	.39	.03	989.
1.01	14.00	84	.42	.39	.03	1060.
1.01	14.10	85	.52	.49	.03	1123.
1.01	14.20	86	.52	.49	.03	1183.
1.01	14.30	87	.52	.49	.03	1243.
1.01	14.40	88	.52	.49	.03	1305.
1.01	14.50	89	.52	.49	.03	1368.
1.01	15.00	90	.52	.49	.03	1429.
1.01	15.10	91	.47	.45	.03	1485.
1.01	15.20	92	.79	.77	.03	1548.
1.01	15.30	93	1.42	1.40	.03	1617.
1.01	15.40	94	3.56	3.53	.03	1798.
1.01	15.50	95	1.03	1.00	.03	2100.
1.01	16.00	96	.63	.61	.03	2525.
1.01	16.10	97	.49	.46	.03	3011.
1.01	16.20	98	.49	.46	.03	3380.
1.01	16.30	99	.49	.46	.03	3650.
1.01	16.40	100	.49	.46	.03	3537.
1.01	16.50	101	.49	.46	.03	3376.
1.01	17.00	102	.49	.46	.03	3134.
1.01	17.10	103	.38	.36	.03	2830.
1.01	17.20	104	.38	.36	.03	2526.
1.01	17.30	105	.38	.36	.03	2295.
1.01	17.40	106	.38	.36	.03	2105.
1.01	17.50	107	.38	.36	.03	1951.
1.01	18.00	108	.38	.36	.03	1813.
1.01	18.10	109	.03	.00	.03	1684.
1.01	18.20	110	.03	.00	.03	1559.
1.01	18.30	111	.03	.00	.03	1422.
1.01	18.40	112	.03	.00	.03	1262.
1.01	18.50	113	.03	.00	.03	1087.
1.01	19.00	114	.03	.00	.03	910.
1.01	19.10	115	.03	.00	.03	741.
1.01	19.20	116	.03	.00	.03	589.
1.01	19.30	117	.03	.00	.03	459.
1.01	19.40	118	.03	.00	.03	356.
1.01	19.50	119	.03	.00	.03	279.
1.01	20.00	120	.03	.00	.03	220.
1.01	20.10	121	.03	.00	.03	177.
1.01	20.20	122	.03	.00	.03	165.
1.01	20.30	123	.03	.00	.03	154.
1.01	20.40	124	.03	.00	.03	143.
1.01	20.50	125	.03	.00	.03	134.
1.01	21.00	126	.03	.00	.03	125.
1.01	21.10	127	.03	.00	.03	116.
1.01	21.20	128	.03	.00	.03	109.
1.01	21.30	129	.03	.00	.03	101.
1.01	21.40	130	.03	.00	.03	95.
1.01	21.50	131	.03	.00	.03	88.
1.01	22.00	132	.03	.00	.03	82.
1.01	22.10	133	.03	.00	.03	77.
1.01	22.20	134	.03	.00	.03	72.
1.01	22.30	135	.03	.00	.03	67.
1.01	22.40	136	.03	.00	.03	62.
1.01	22.50	137	.03	.00	.03	58.
1.01	23.00	138	.03	.00	.03	54.
1.01	23.10	139	.03	.00	.03	51.
1.01	23.20	140	.03	.00	.03	47.
1.01	23.30	141	.03	.00	.03	44.
1.01	23.40	142	.03	.00	.03	41.
1.01	23.50	143	.03	.00	.03	38.
1.02	0.00	144	.03	.00	.03	36.
1.02	.10	145	0.00	0.00	0.00	33.
1.02	.20	146	0.00	0.00	0.00	31.
1.02	.30	147	0.00	0.00	0.00	29.
1.02	.40	148	0.00	0.00	0.00	27.
1.02	.50	149	0.00	0.00	0.00	25.
1.02	1.00	150	0.00	0.00	0.00	24.
		SUM	24.34	20.54	3.80	72861.
			(618.)(522.)(96.)(2063.19)			

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3550.	1014.	506.	486.	72856.
CMS	101.	51.	14.	14.	2063.
INCHES		18.75	20.92	20.92	20.92
MM		476.29	531.28	531.31	531.31
AC-FT		900.	1003.	1004.	1004.
THOUS CU M		1110.	1238.	1238.	1238.

HYDROGRAPH AT STA LAKE FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1775.	907.	253.	243.	36428.
CMS	50.	26.	7.	7.	1032.
INCHES		9.38	10.46	10.46	10.46
MM		238.15	265.64	265.65	265.65
AC-FT		450.	502.	502.	502.
THOUS CU M		555.	619.	619.	619.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE DISCHARGE THRU DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-168.	-1

STAGE	167.50	167.90	169.00	170.00	171.00	172.00	173.00	175.00
FLOW	0.00	5.00	86.00	223.00	392.00	584.00	801.00	1298.00
SURFACE AREA=	0.	12.	48.	129.	253.			
CAPACITY=	0.	69.	418.	2116.	5858.			
ELEVATION=	150.	168.	180.	200.	220.			

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
167.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
170.0	2.6	1.5	285.

STATION DAM, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	1.	1.	1.
2.	2.	2.	3.	3.	4.	5.	5.	8.	11.
14.	16.	19.	21.	25.	31.	40.	52.	67.	84.
118.	153.	189.	223.	332.	444.	526.	584.	629.	667.
701.	732.	764.	816.	910.	1060.	1265.	1483.	1649.	1731.
1729.	1661.	1547.	1409.	1276.	1163.	1070.	991.	920.	855.
791.	722.	647.	567.	487.	411.	344.	287.	243.	219.
207.	194.	181.	170.	159.	148.	138.	129.	120.	112.
104.	97.	90.	85.	82.	78.	75.	72.	69.	66.
63.	60.	57.	55.	52.	50.	47.	45.	43.	41.

STORAGE

69.	69.	69.	69.	69.	69.	69.	69.	69.	69.
69.	69.	69.	69.	69.	69.	69.	69.	69.	69.
69.	69.	69.	69.	69.	69.	69.	69.	69.	69.
69.	69.	69.	69.	69.	69.	69.	69.	69.	69.
69.	69.	69.	69.	69.	69.	69.	69.	69.	69.
69.	69.	69.	69.	70.	70.	70.	70.	70.	71.
71.	71.	72.	72.	73.	73.	74.	74.	75.	75.
76.	76.	77.	77.	78.	79.	81.	83.	86.	89.
93.	97.	101.	106.	109.	112.	114.	115.	115.	116.
117.	117.	118.	119.	120.	123.	126.	129.	131.	132.
132.	131.	130.	128.	126.	124.	123.	122.	120.	119.
118.	117.	116.	114.	113.	111.	110.	108.	107.	105.
103.	102.	100.	99.	98.	97.	95.	94.	93.	92.
92.	51.	90.	89.	89.	88.	87.	87.	86.	86.
85.	84.	84.	83.	83.	82.	82.	81.	81.	81.

STAGE

167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5
167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5
167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5
167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5
167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5
167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.5	167.6	167.6
167.6	167.7	167.7	167.7	167.8	167.8	167.9	167.9	167.9	168.0
168.0	168.1	168.1	168.1	168.2	168.3	168.4	168.5	168.7	169.0
169.2	169.5	169.7	170.0	170.2	170.4	170.5	170.5	170.6	170.6
170.6	170.7	170.7	170.7	170.8	170.9	171.1	171.2	171.4	171.4
171.4	171.4	171.3	171.2	171.1	171.0	170.9	170.9	170.8	170.6
170.7	170.6	170.6	170.5	170.4	170.3	170.2	170.1	170.1	170.0
169.9	169.8	169.7	169.6	169.5	169.5	169.4	169.3	169.3	169.2
169.1	169.1	169.0	169.0	168.9	168.9	168.9	168.8	168.8	168.7
168.7	168.7	168.6	168.6	168.5	168.5	168.5	168.4	168.4	168.4

TFLOW IS 1731. AT TIME 16.67 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1731.	879.	247.	237.	35608.
CMS	49.	25.	7.	7.	1008.
INCHES		9.08	10.22	10.22	10.22
MM		230.70	259.67	259.67	259.67
AC-FT		436.	490.	490.	490.
THOUS CU M		537.	605.	605.	605.

SUMMARY OF DAM SAFETY ANALYSIS

.....		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	167.50	167.50	170.00
	STORAGE	69.	69.	106.
	OUTFLOW	0.	0.	223.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	171.41	1.41	132.	1731.	5.83	16.67	0.00
.40	171.18	1.18	127.	1381.	5.50	16.83	0.00
.30	170.91	.91	122.	1033.	4.83	16.83	0.00
.20	170.61	.61	116.	681.	3.50	16.83	0.00
.10	170.07	.07	107.	247.	.83	17.33	0.00

APPENDIX 5

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